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Joint Estimation of Farmers' Stated Willingness to Pay for Agricultural Services

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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Contents

List of Tables

List of Figures

ABSTRACT

In many developing countries, to sustain the provision of agricultural services to farmers, many have advocated the use of service fees. Successful implementation of such schemes requires understanding of determinants of farmers' willingness to pay. In this paper we use a multivariate probit approach to investigate farmers' stated willingness to pay for different agricultural services including soil fertility management, crop protection, farm management, improved produce quality /varieties, on-farm storage (post-harvest), improved individual and group marketing, and disease control. Data are from the Uganda National Household Survey 2005/2006. Controlling for individual characteristics and regional heterogeneity, our results suggest that farmers with access to information on proposed agricultural service are less willing to pay for it. Similarly, access to extension service tends to reduce farmers' willingness to pay. Market access plays also a significant role; farmers with available market are more willing to pay for agricultural services than those without available market. On the reverse, distance to the market is inversely correlated with the willingness to pay for agricultural services. The results also suggest that land ownership matters; indeed, increase in the size of land owned by farmers increases their willingness to pay for agricultural services. As expected, farmers' income, especially agricultural income significantly increases farmers' willingness to pay for agricultural services. Overall, decisions to pay or not for these services are not independent from each other implying that joint supply of these services should be recommended.

Keywords: agricultural services, willingness to pay, multivariate probit, market, farmer

1. INTRODUCTION

Over the past two decades, fundamental political, economic, and social changes have taken place in many developing countries as a result of liberalization, structural adjustment programs, and transition from centrally planned to market economies. Accordingly, agricultural research and extension services have been restructured to be provided either by the private sector or through improved public entities. The sustainability of the latter depends on resource availability, whereas provision by the private sector is very much a function of farmers' willingness to pay.

Agricultural research and extension systems in developing countries are confronted with the challenge of providing adequate educational and technical extension programs for all groups of farmers due to a significant decline of government expenditure in national budgets (Swanson and Samy 2002). The international donor community has emphasized the importance of reorganizing the provision of agricultural technologies in developing countries through restructuring national agricultural research and extension services, supporting the promotion of agricultural services for markets, and promoting consumer-oriented agribusiness and agrifood systems. Strategies implemented to support such restructuring vary from country to country. On one hand, this restructuring reflects effective demand on the part of actors in the agrifood system. On the other hand, it depends on a country's supply factors, such as the cost and efficiency of services provided by both the public and private sectors.

The rationale for private provision of agricultural services in developing countries is often based on a cost-recovery approach, which critically depends on two factors: (1) how the extension system (public and private) provides advisory services to farmers' satisfaction; and (2) the financial sustainability of such systems. However, more research is required to assess the effectiveness of the cost-recovery approach by evaluating how much farmers are willing to pay for selected technologies and advisory services (Rivera and Zijp 2002; Chapman and Tripp 2003; McFeeters 2004).

Smallholder farmers in Uganda, as well as in many other countries in sub-Saharan Africa, have several common characteristics, such as being seasonal producers; fragmented buyers and suppliers, who are unable to exploit economies of scale; and dominated by household economies, where functions such as consumption, investment, and work are unspecialized. Small farmers in Uganda (especially in the rainfed areas) are faced with constraints in the production process, in access to inputs and credit, and in marketing and value addition. The production level of these smallholder farmers is further constrained by their small landholdings, by weaknesses in the land tenure system, and by unequal access to irrigation water. Furthermore, they face difficulty in procuring and applying for modern technologies due to the high costs and greater risks involved.

Lack of resources, inadequate market access, poor knowledge of value-added services, and lack of institutions and infrastructure tend to put Ugandan smallholder farmers at a disadvantage in the global marketplace. This disadvantage is further compounded by low levels of education and a lack of group organization, the latter of which reduces farmers' bargaining power. To enable small farmers to reap the benefits of globalization, the Ugandan government must play a proactive role in empowering them to take advantage of new market opportunities. Empowering farmers will require the government to undertake land reforms, ensure access to credit, promote soil fertility management, encourage best practices in farm management, and improve postharvest practices. Innovative institutional arrangements would need to be developed to make the extension system farmer driven and farmer accountable. Credit and thrift societies will need to be encouraged at the farm level to serve as an effective mechanism of low-transaction-cost credit delivery to smallholders. Both private-sector and government service providers will need to be encouraged through the creation of an enabling environment and a level-playing field.[1]

Experience from other regions, such as Asia-Pacific, demonstrates that the strength of smallholder farmers lies in group mobilization to meet diverse agricultural needs, such as accessing inputs, pooling resources, sharing information, and, most important, using credit groups (such as

[1] We are grateful to an anonymous referee for pointing this out.

Grameen Bank in Bangladesh) for consumption and production loans. In this new economic environment, the private sector will play a key role in providing a variety of agroservices. The role of government would involve performing quality control of inputs such as seeds, pesticides, and fertilizers; improving accountability of all private-sector providers of agroservices to farmers; and ensuring transparency through the provision of information. In this new scenario, the role of public agencies would need to be reexamined from that of being sole providers of agroservices to being facilitators and regulators of the supply system. The overall environment of the private provision of agroservices will need to be encouraged through policy reforms and institutional changes so that farmers' needs are serviced more efficiently.

Because research-based agricultural services are central for agricultural growth, food security, and poverty reduction in developing countries, two fundamental questions must be addressed:

1. To what extent do smallholder farmers in developing countries have access to agricultural services, despite the reduction in government funding?
2. What factors determine willingness to pay for different services in order to encourage private-sector involvement?

Previous approaches to modeling households' willingness to pay (WTP) for agricultural technologies in developing countries usually used a contingent valuation method, which utilizes surveys to determine how consumers evaluate goods and services when markets are missing (Holden and Shiferaw 2002; Horna, Smale, and Oppen 2005; Oladele 2008). Dichotomous-choice or single-bound questioning has been used to ask respondents whether they would be willing to pay a single price for the good. Although this question is relatively easy for respondents to answer, it provides only a limited amount of information.

This paper uses the Ugandan National Household Survey (UNHS) of 2005/06 in order to examine the factors influencing farmers' willingness to pay for agricultural services. More specifically, the paper intends to determine

1. key factors influencing the willingness of farmers to pay for agricultural services, while also controlling for demographic factors and other covariates;
2. the significance of the correlation between farmers' willingness to pay for different technologies.

This paper is organized as follows: The next two sections describe the conceptual framework and provide a brief overview of the literature. Section 4 discusses the data, descriptive statistics, and the key estimation results. Section 5 concludes with a few policy implications of the main results.

2. CONCEPTUAL FRAMEWORK AND METHODS FOR ESTIMATING WILLINGNESS TO PAY

Following Holden and Shiferaw (2002), we model willingness to pay (WTP) as a sacrifice of current income in order to sustain or increase agricultural productivity in the future. The minimum expenditure level required to achieve the initial utility level is given by

$$e(p, EU_0, F_0), \tag{1}$$

where p is the vector of prices, EU_O is the current expected utility level, and F_0 is the set of old agricultural services and farm characteristics. It follows that the WTP in order to sustain current productivity is given by

$$WTP = e(p, EU_0, F_0) - e(p, EU_0, F_1), \tag{2}$$

where WTP is the amount that leaves the household indifferent between the expected marginal utility under the old set of technologies and the discounted expected marginal utility of the change in future incomes as a result of the new set of agricultural technologies; F_1 is the new set of agricultural services and farm characteristics. Assuming that the individual household maximizes expected intertemporal utility, we have

$$E[-U_{i0}(C_{i0}) + U_{i0}(C_{i0} - WTP_i) + \sum_{t=1}^{\infty}(1+\delta_i)^{-t} U_{it}(C_{1it} - C_{0it})] = 0 \tag{3}$$

where δ_i represents a household's constant rate of time preferences; C is household consumption; and $U_{it}(C_{1it} - C_{0it})$ is the utility level available to household i from the difference in land productivity induced by adoption of new agricultural technologies.
The Euler equation of (3) is given by

$$U'_{i0}(C_{i0})(WTP_i) = \sum_{t=1}^{\infty}(1+\delta_i)^{-t} EU'(C_{it})\, dC_{it}. \tag{4}$$

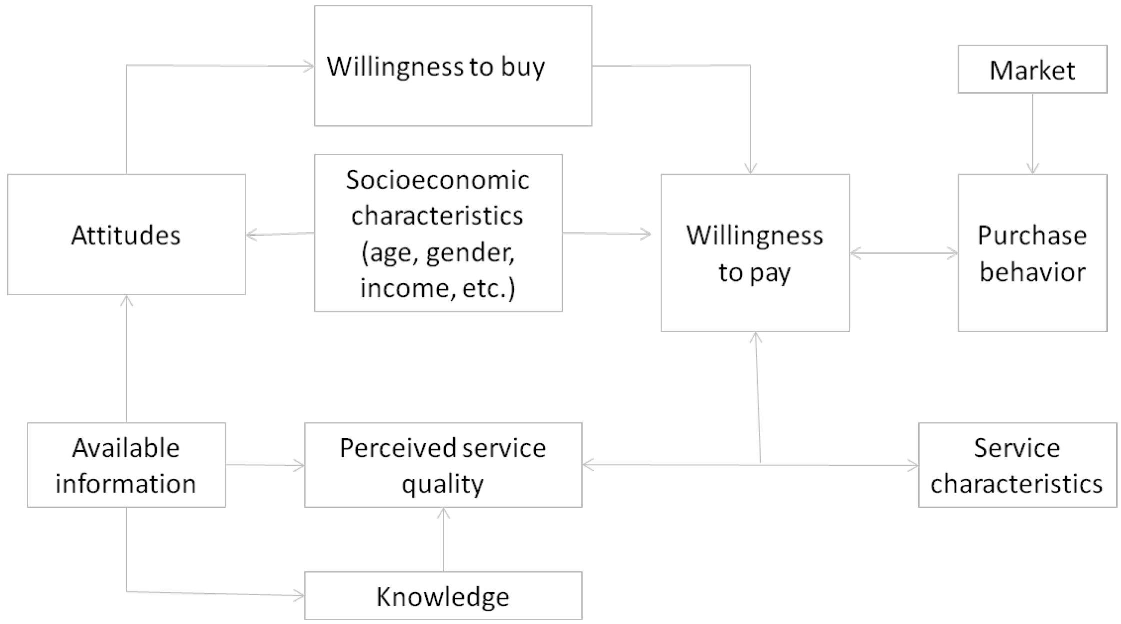
Therefore,

$$WTP = \sum_{t=1}^{\infty}(1+\delta_i)^{-t}\{EU'\,(C_{it})/U'_{i0}(C_{i0})\}\, dC_{it} \tag{5}$$

As pointed out by Holden and Shiferaw (2002), estimation of WTP WTPat the household level has both theoretical and empirical implications, because farm investment decisions depend on consumption as well as production parameters. Indeed, market imperfections lead to nonseparability between consumption and production decisions (Singh, Squire, and Strauss 1986; De Janvry, Fafchamps, and Sadoulet 1991). In Section 3, we present a literature review of the main determinants of willingness to pay for agricultural technologies in African countries.

Overall, following Aryal et al. (2009), farmers' willingness to pay for a given agricultural service is a function of knowledge, attitude, and intention (Figure 2.1). Available information influences both knowledge and attitude toward the proposed service. Socioeconomic characteristics such as age, gender, and income also shape a consumer's willingness to pay, because those characteristics affect attitudes toward agricultural service. In addition, market characteristics such as accessibility and prices affect purchase behavior and ultimately farmers' willingness to pay.

Figure 2.1—Farmer's willingness to pay for agricultural services



Source: Adapted from Aryal et al. (2009).

As pointed out by Birner et al. (2006), the WTP approach could be used to estimate the direct benefit of agricultural advisory services in the absence of a market for such services. The application of such methods in various country settings and agroecological zones can shed light on actual benefits and costs of advisory services.

There are two main ways of determining WTP for advisory services: (1) a direct or contingent valuation method and (2) an indirect or estimation of demand and supply for agricultural services. Gautam (2000) in Kenya and Sulaiman and Sadamate (2000) in India provided examples of WTP estimation. In both cases, WTP for advisory services was examined through contingent valuation methods. In the Sulaiman and Sadamate study, farmers were asked directly about their WTP for extension services and valid agricultural information. The authors used a linear discriminant function analysis to predict farmers' behavior and evaluate the determinants of their willingness to pay. A caveat of this approach is that the WTP is a hypothetical value, and hypothetical values need not be correlated with the readiness to pay. This methodology is appropriate when farmers know about fee-based advisory services, as in the case of India. Despite the widespread use of stated preferences used in the literature, many researchers question their use in determining the WTP for a given good or service.

Several studies have used the indirect estimation method to determine WTP for advisory services. Dinar (1996) estimated the demand and supply for advisory service visits in Israel and then derived the WTP for these services per hectare value added by subtracting the production cost (including extension) from the revenue. Such an approach can only be implemented in places where the demand for advisory services is high and perfectly revealed. This method requires detailed information about not only farm production but also extension performance. Holloway and Ehui (2001) estimated WTP of dairy producers for individual advisory service visits in Ethiopia. The study used a traditional consumer model and focused on cash income constraint to derive the amount of income that a household is willing to forgo to obtain an additional unit of service rendered. The decision of the dairy producer then becomes whether to participate in the market. The suitability of this method depends on the reliability of market prices and the extent to which the production system is commercially oriented.

Horna, Smale, and Oppen (2005) examined farmers' preferences for new rice varieties seed and their willingness to pay for information as a measure of WTP for rice production advisory services in

Nigeria and Benin. Farmers' preferences were modeled as a function of the utility obtained from rice seed varieties, the farmer's social and economic characteristics, and the level of information about the varieties. Conjoint utility analysis was used to estimate the marginal values of rice seed attributes and to derive the WTP for seed-related information. The results of the study indicated that variety attributes are important determinants of the seed preferences stated by farmers; however, in many cases, the sign of the coefficient contradicted what was sought by rice researchers.

Given the discrete nature of farmers' decision processes, qualitative choice models are often most appropriate for analytical purposes. Such models include the linear probability model (Falusi 1975; Capps, Moen, and Branson 1988), the probit model (Hausman and Wise 1978; McFadden 1981), and the logit model (Press and Wilson 1978; Jones and Landwehr 1988). The probability model suffers from three important shortcomings: the error term is heteroscedastic, the error term has elements of nonnormality, and the predicted value of the dependent variable may not fall within the unit interval (McFadden 1981). Although generalized least squares may circumvent the problem of heteroscedasticity, truncating values of the dependent variable through logit models can still leave unresolved the problem of estimating parameters of a threshold decision model (White , 1980).

Among discrete choice models, the multinomial logit (MNL) and the multinomial probit (MNP) models are the most commonly used. Technically, the two models are similar expect for the nature of the distribution of the error terms. In the MNL model, the errors are independent and identically distributed according to the type 1 extreme value distribution (Greene 2003, 858), whereas in the MNP model, the errors are not necessarily independent and are distributed as multivariate normal (Greene 2003, 856). Although this difference may seem rather minor, it has a significant effect in practice. Indeed, the independent errors of MNL force an assumption called the independence of irrelevant alternatives (IIA), which requires that an individual's evaluation of an alternative relative to another alternative should not change if a third (irrelevant) alternative is added to or dropped from the analysis. On the other hand, although the MNP model is computationally intensive, it does not assume IIA; therefore, many researchers have assumed that MNP is a better model (see Alvarez and Nagler 1998, 2000). In the present study, we use a multivariate probit model, because the IIA assumption may not apply to farmers' willingness to pay for agricultural technologies that are not perfectly substitutable.

As Young, Valdez, and Kohn (2009, 6) rightfully pointed out, "In an analysis of correlated quantal response data, one must account for the correlation structure between different levels of response if, a priori, there is a perceived possibility that these responses may in fact be correlated." We believe this is the case for willingness to pay for agricultural services in which farmers' decisions about one type of service is likely to be correlated with their decision on another type of service. This assumption justifies the use of the multivariate probit model described below.[2]

Let I_j^i denote farmer *i*'s binary response outcome associated with each *j* type of agricultural service, for *j* = 1, . . . , *J*, such that I_j^i is 1 if farmer *i* is willing to pay for services *j* and 0 otherwise. It follows that the multivariate probit (MVP) model can be specified as a linear combination of a deterministic and stochastic component:

$$\begin{gathered} I_1^i = x'\beta_1 + \epsilon_1, \\ \cdots\cdots\cdots, \\ I_J^i = x'\beta_J + \epsilon_J. \end{gathered} \tag{6}$$

where $x = (1, x_1, \ldots, x_p)'$ is a vector of *p* covariates, which do not differ for each type of agricultural services, and $\beta_j = (\beta_{j0}, \beta_{j1}, \ldots, \beta_{jp})$ is a corresponding vector of parameters to be estimated. The error term ϵ_j consists of those unobservable factors affecting the marginal probability of WTP for a type *j* of

[2] We undertake this test, and the results reject the assumption of nonsignificant correlation. Thus, we use MVP. The results can be obtained from the authors upon request.

agricultural service. Each ϵ_j is drawn from a J-variate normal distribution with zero conditional mean and variance normalized to unity (for parameter identification); $\epsilon \sim N(0, \Sigma)$ with the covariance given by

$$\Sigma = \begin{bmatrix} 1 & \rho_{12} & \cdots\rho_{1J} \\ \rho_{21} & 1 & \cdots\rho_{2J} \\ \rho_{J1} & \rho_{J2} & \cdots\ 1 \end{bmatrix}. \tag{7}$$

The off-diagonal elements in the covariance matrix ρ_{sj} represent the unobserved correlation between the stochastic component of the sth and the jth types of agricultural services.

As pointed out by Cappellari and Jenkins (2003), the model's structure is similar to that of the seemingly unrelated regression (SUR) model, except that the dependent variables are binary indicators. The model is estimated using the Geweke-Hajivassiliou-Keane (GHK) smooth recursive conditioning simulator.[3]

[3] See Börsch-Supan et al. (1992), Börsch-Supan and Hajivassiliou (1993), Keane (1994), Hajivassiliou and Ruud (1994), Greene (2003, 931–933), Cappellari and Jenkins (2003), and Gates (2006) for additional details.

3. DETERMINANTS OF WILLINGNESS TO PAY FOR AGRICULTURAL TECHNOLOGIES IN AFRICAN COUNTRIES

Most current strategies for economic development in Africa give increasing attention to the need for significant improvements in agricultural productivity in order to achieve GDP growth, food security, and poverty reduction goals (that is, the Millennium Development Goals and the New Partnership for Africa's Development). Much of the research on African agriculture demonstrates that farmers' failure to intensify agricultural production is a key component of inefficiency and lower productivity (Crawford, Jayne, and Kelly 2006).

Jayne et al. (2003), for example, reported that the high overall costs of exchange of fertilizer compared with farmers' willingness to pay (WTP) limit the size of the market and the use of fertilizer. Horna, Smale, and Oppen (2005) interpreted the situation as being a result of inefficiencies in resource allocation that occurs when a service, such as extension, is provided free to farmers who might be able or willing to contribute in order to obtain appropriate services. Consequently, it is important to know how much farmers and consumers would be willing to pay for agricultural technology and what the determinants of households' WTP are in order to develop appropriate technology adoption strategies.

Literature on WTP for agricultural technologies in Africa is rather scant. Research results reveal that the magnitudes of households' WTP for agricultural technologies, as well as the type of payment, vary with the nature of the technology. Holloway and Ehui (2001), for example, looked at the impacts of extension on participation of dairy producers in Ethiopia's milk market and the amount that households would be willing to pay for the extension service. Based on the WTP estimates and the per-unit cost estimates of the extension visit, the authors found that privatization of extension services is a possibility in the context of milk market development. Asrat, Belay, and Hamito (2004) examined the determinants of farmers' WTP for soil conservation practices in Ethiopia's southeastern highlands and reported that the majority of the farmers in the study area were less willing to pay cash. However, the farmers were willing to spend substantial amounts of labor and time on soil conservation.

Karshenas and Stoneman (1993) argued that economies of scale should be used as a criterion to decide whether to invest in new technology. They found that the decision to adopt new technologies came sooner for larger farms. However, farm size may not be as important for improved varieties of crop as it is for other technologies. Seed can be bought in small lots, and the initial investment required to try the seed is not large. Thus, there may be a higher propensity to adopt a new crop, even by smaller farms, than there is to adopt a new technology that requires a large capital outlay (McCorkle 2007). Similarly, results from Asrat, Belay, and Hamito (2004) on the determinants of farmers' WTP for soil conservation practices in the southeastern highlands of Ethiopia show that the size of noncropland affects farmers' WTP negatively and significantly. This result is attributable to the fact that the economic impact of soil erosion on noncropland is less than it is on cropland. Therefore, as more and more land is taken out of cultivation, farmers' desire to participate in soil conservation practices declines.

Similarly, tenure insecurity could be a reason for farm households to have low WTP for conservation (Holden and Shiferaw 2002). This hypothesis is supported by Asrat, Belay, and Hamito (2004), who stated that the size of rented-in farmland was found to have a negative and significant effect on farmers' WTP for soil conservation measures. The possible explanation is that in most cases, land renting contracts are short term, which may not encourage farmers who rent-in land to undertake conservation practices, because conservation investments pay back only in the long term.

A study that looked at irrigation adoption found that small farmers with more profit per unit of land than average were more likely to contribute to irrigation (Koundouri, Nauges and Tzouvelekas, 2006). This could be because the use of irrigation equipment is labor intensive and time consuming, so it is more appropriate for small farmers' intensive operations.

Another factor expected to have an influence on farmers' WTP for agricultural technologies is education. A higher level of education is expected to increase farmers' ability to get, process, and use information. Thus, education is hypothesized to have a positive role in the decision to pay for new agricultural technologies. This positive effect was found in several studies on farmers' WTP for sustained land productivity technologies in Ethiopia (Holden and Shiferaw 2002; Asrat, Belay, and Hamito 2004); extension visitation or other extension services in Uganda, Ethiopia, and Nigeria (Faye and Deininger 2005; Holloway and Ehui 2001; Oladele 2008); and input investment in Ethiopia, Kenya, Zambia, Madagascar, and Nigeria (Jayne et al. 2003; Minten, Randrianarisoa, and Barrett 2007).

Farm and nonfarm income are also expected to have an impact on farmers' decision to invest in agricultural technologies. Nonfarm income is expected to have a positive influence, given the assumption that diversification out of agriculture would enable households to earn income, thereby easing the liquidity constraint needed for new technology investments (Pender and Kerr 1998; Holden and Shiferaw 2002). On the other hand, poverty reduces a household's willingness and ability to invest in agricultural technologies (Holden and Shiferaw 2002). Empirical studies have reported positive relationships between income and adoption of agricultural technologies (Ervin and Ervin 1982; Clay, Reardon and Kangasniemi, 1998; Holden and Shiferaw 2002; Faye and Deininger 2005).

With respect to family size, one can expect a larger family to have a higher probability of possible future benefits from new technology investments. Results from aforementioned studies indicate that households with more human capital are more likely to adopt new technologies that require more labor.

The impact of a farmer's age can be considered a combination of the effect of farming experience and planning horizon. Although longer experience has a positive effect, young farmers may have longer planning horizons and, hence, may be more likely to invest in agricultural technologies (Asrat, Belay, and Hamito 2004; Faye and Deininger 2005; Holden and Shiferaw 2002).

The awareness level of agricultural technology is hypothesized to have a positive effect on willingness to participate in technology investments (Pender and Kerr 1998). Asrat, Belay, and Hamito (2004) found that farmers who were aware of the available options for agricultural technology were more receptive to paying for these technologies.

4. DATA AND DESCRIPTIVE ANALYSIS

In this study, we use the Ugandan National Household Survey (UNHS), which has been carried out by the Uganda Bureau of Statistics (2006) every other year since the late 1980s. As with previous surveys, the UNHS 2005/06 used a stratified two-stage sampling design, with the selection of the enumeration areas (EA) at the first stage and the selection of the household at the second stage. A sample of about 750 EAs were selected, and 10 households were then selected randomly from each EA. In some districts of northern Uganda, where large populations have been displaced by the Lord's Resistance Army (LRA) war and are living in internally displaced people (IDP) camps, a three-stage sampling design was adopted, with the selection of the IDP as the first stage unit, the respective "blocks" within the camp as the second stage selection, and the households within the blocks as the third stage selection.

Farmers' Willingness to Pay for Agricultural Services and Access to Agricultural Technology

The UNHS 2005/06 covered about 7,400 nationally representative households (Uganda Bureau of Statistics 2006). The survey had five modules: socioeconomic, agriculture, community, market, and qualitative. The UNHS 2005/06 included data on household access to agricultural services and related willingness to pay (WTP) for those services. Agricultural services include soil fertility management, crop protection, farm management, improved commodity quality and varieties, on-farm storage (postharvest), improved individual and group marketing, and disease control. Except for the improved quality technology, households reported less than 50 percent access to farm management, on-farm storage, and improving marketing technologies (Table 4.1). Mass media and farmer-to-farmer interaction are the most popular channels of access to most agricultural services, accounting for 74–80 percent, whereas extension service and National Agricultural Advisory Services (NAADS **)** represent 17–22 percent.

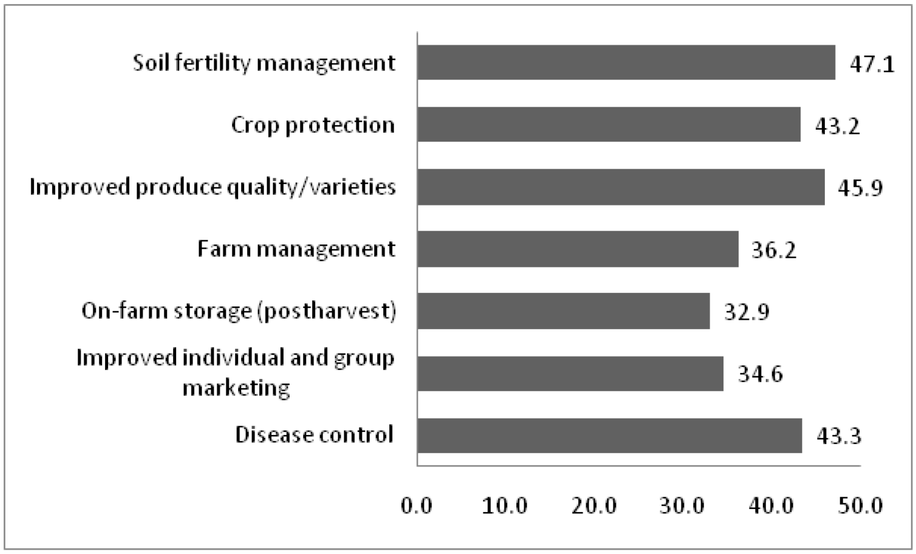
Table 4.1—Farmers' access to agricultural technology (%)

	Soil fertility management	Crop protection	Farm management	Improved quality	On-farm storage	Improved marketing	Disease control
No access	56.4	60.3	69.7	44.8	70.6	71.0	56.5
Have access	43.6	39.7	30.3	55.2	29.4	29.0	43.5
Through extension	4.0	3.8	3.3	4.2	2.3	2.3	4.7
Through NAADS	5.0	4.3	3.5	5.0	2.8	2.8	3.3
Through mass media	18.0	15.6	12.4	19.1	10.6	11.1	16.0
Through exchange with other farmers	15.1	14.6	9.9	24.9	12.8	11.7	17.8
Other	1.5	1.4	1.1	2.1	0.9	1.2	1.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations from UNHS 2005/06.

Across these services, farmers' willingness to pay varies from 32.9 percent for on-farm storage to 47.1 percent for soil fertility management (Figure 4.1). Traditional productivity-enhancing services, such as improved varieties and soil fertility management, are the most demanded.

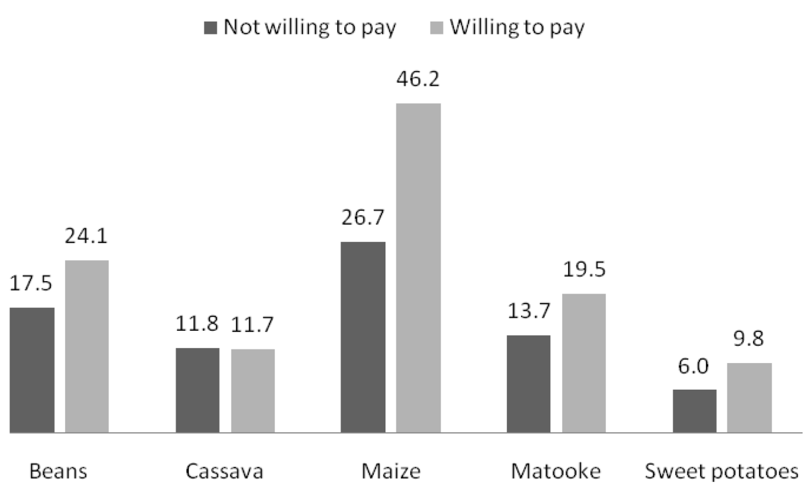
Figure 4.1—Farmers' willingness to pay for agricultural services (%)



Source: Authors' calculations from UNHS 2005/06.

Figure 4.2 presents farmers' willingness to pay with respect to the share of sold outputs by crops. Except for cassava, quantity sold as share of total output is positively correlated with willingness to pay for agricultural services, which indicates that access to market does matter when farmers decide whether to pay for agricultural services.

Figure 4.2—Farmers' willingness to pay for agricultural services and quantity sold (%)



Source: Authors' calculations from UNHS 2005/06.

Correlation Coefficient of the Willingness to Pay for Agricultural Services

The first-order correlation coefficients (Table 4.2) are all significantly positive and higher than 89 percent, suggesting that an increase in the WTP for one service is more likely to induce an increase in the WTP for other services and vice versa.

Table 4.2—First-order correlations between willingness to pay for agricultural services

	Soil fertility management	Crop protection	Farm management	Improved quality	On-farm storage	Improved marketing	Disease control
Soil fertility management	1						
Crop protection	0.912	1					
Farm management	0.907	0.947	1				
Improved quality	0.893	0.926	0.958	1			
On-farm storage	0.912	0.906	0.949	0.938	1		
Improved marketing	0.907	0.915	0.957	0.962	0.952	1	
Disease control	0.895	0.891	0.947	0.956	0.941	0.968	1

Source: Authors' calculations from UNHS 2005/06.

Estimation Results

We implemented the multivariate probit estimation procedure while controlling for farmers' demographics, such as age, gender, and marital status. We also accounted for regional fixed effects. As expected, the willingness to pay for one agricultural service is significantly correlated with the willingness to pay for other services. Econometrically, this means that separately estimating willingness to pay for different agricultural services is likely to yield biased estimates and therefore erroneous policy recommendations.

Across agricultural services, the results suggest that prior access to extension services tends to reduce farmers' willingness to pay (Table 4.3). One would expect that prior access to agricultural services would increase farmers' willingness to pay for them. The observed negative effect can be explained by farmers' appreciation of the services being offered. As shown in Table 4.4, on average, 22.3 percent of farmers appreciate both the quality and frequency of supplied services. However, at least 50 percent of farmers complained about irregular frequency. In addition, the results suggest that farmers who already have adequate access to agricultural services are less willing to pay for them, suggesting that farmers' attitudes toward the proposed services matter.

Table 4.3—Key estimation results[4]

	Soil fertility management	Crop protection	Farm management	Improved produce quality/ varieties	On-farm storage (post harvest)	Improved individual and group marketing	Disease control
Access to extension service*	–0.1831	–0.2540[c]	–0.4614[a]	–0.3418[b]	–0.3458[a]	–0.2133	–0.5573[a]
Access to technology*	–0.2626[a]	–0.3476[a]	–0.2828[a]	–0.3161[a]	–0.3230[a]	–0.3341[a]	–0.3704[a]
Market availability*	0.1254	0.1684	0.3094[c]	0.2580	0.3416[a]	0.3267[b]	0.2794[b]
Travel time to the market (minutes)	–0.0006	–0.0006	–0.0009[b]	–0.0004	–0.0009[b]	–0.0004	–0.0006
Owned land (Ha)	0.0373[a]	0.0403[a]	0.0440[a]	0.0291[a]	0.0322[b]	0.0340[a]	0.0451[a]
Farming revenue**	0.0001	0.0002[c]	0.0002[b]	0.0002[b]	0.0001[c]	0.0003[a]	0.0002[b]
Nonfarming revenue**	0.0003[b]	0.0004[a]	0.0002[b]	0.0003[a]	0.0003[a]	0.0003[b]	0.0002[c]

Source: Authors' calculations from UNHS 2005/06.
Note: a,b, and c means significant at 1%, 5%, and 10%, respectively. * Binary variable; ** Ugandan shillings.

[4] Detailed results are presented in the appendix.

Table 4.4—Farmers' appreciation of agricultural services

	Soil fertility management	Crop protection	Farm management	Improved produce quality/ varieties	On-farm storage (post harvest)	Improved individual and group marketing	Disease control
Good quality and frequent	23.2	22.5	22.1	21.8	21.3	22.3	23.1
Good quality but infrequent	55.4	54.7	53.4	52.8	53.1	49.0	55.3
Frequent but insufficient content	15.2	16.4	17.2	18.3	16.8	19.1	15.4
Not useful	6.2	6.4	7.3	7.1	8.8	9.6	6.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations from UNHS 2005/06.

As expected, the results from Table 4.3 suggest that market availability increases farmers' willingness to pay for agricultural services, except for soil fertility management and crop protection services. This result is confirmed by the negative impact of travel distance on the willingness to pay for agricultural services. As pointed out by Chipeta (2006), demand-driven agricultural advisory services are usually enhanced by improved access to markets for the farmers. Thus, improving access to markets and increasing farmers' share of benefits from commercial agriculture are the key determinants of farmers' appreciation of agricultural services.

Although the literature has extensively examined the impact of land tenure on agricultural productivity in Africa (for an extensive review, see Place 2009), we were unable to find a single study on the link between land tenure and access to agricultural services. Feder (1988) hypothesized three important kinds of economic relationships that govern the linkages between land tenure and access to agricultural services: (1) title can be used as collateral to improve access to credit for agricultural investment; (2) title could increase security of tenure for farmers and enhance their willingness to make medium- to long-term investments on their land; and (3) title may stimulate land markets that will facilitate the transfer of land resources to more-productive farmers.

We can thus infer that land ownership, which guarantees security of tenure for farmers, is likely to increase their willingness to pay for agricultural services. Our findings suggest that regardless of the type of agricultural services, an increase in the size of purchased or owned land increases farmers' WTP for agricultural services. In other words, lack of land ownership can act as a significant constraint to farmers' willingness to pay. Both farming and nonfarming revenues significantly affect farmers' willingness to pay. Even a marginal increase in farmers' income increases their probability of paying for agricultural services. This result is consistent with literature in Nigeria, which found that the majority of farmers were willing to pay for agricultural services if their income from farming were to increase in the future (Ajayi 2006).

5. CONCLUDING REMARKS

Previous approaches to modeling households' willingness to pay (WTP) for agricultural technologies in developing countries usually used a contingent valuation method to determine how consumers evaluate goods and services when markets are missing. Some studies also used dichotomous-choice question to ask respondents whether they would be willing to pay a single price for the technology. Although these approaches are relatively easy to implement, they provide the researcher with only a limited amount of information.

In this paper, we implement the multivariate probit model to capture the key determinants of farmers' WTP for agricultural services. Our results suggest that farmers' WTP for one service is significantly and positively correlated with their WTP for other services. Aside from its technical implication of yielding consistent estimates, this finding suggests that agricultural services can be viewed as complements. In other words, agricultural services should not be treated independently of one another. Consequently, the supply of agricultural services should be organized as a joint production system.

Moreover, our results indicate that farmers with prior access to agricultural and extension services are less willing to pay for them. We also found that without proper access to market, farmers are less likely to pay for agricultural services. Regardless of the type of agricultural services, land ownership increases farmers' willingness to pay. Finally, our findings confirm that the level of farming income plays a major role in the decision of whether to pay for agricultural services.

The results from our study can be used to improve private-sector provision of agricultural advisory services as part of the effort to revitalize the agricultural sector in developing countries. In countries where the public sector cannot deliver the required agricultural advisory services to otherwise low-income farmers, farmers' revealed preferences can be used to help determine the value of provision of such services so as to understand the desirable changes that should occur on equity and efficiency grounds. New institutional arrangements, such as partnerships between the public and private sector as well as hybrid systems, can still be useful for providing such services. In high-income countries with educated farmers, a mixed system based on a fixed contribution and fees for such services can be adopted.

Although willingness to pay is an important concept for ex-ante evaluations, it is not enough to incorporate farmers' financial contributions. Thus, an important question for future research in this area is whether advisory services are increasing farmers' ability to pay.

APPENDIX: SUPPLEMENTARY TABLE

Table A.1—Detailed estimation results

	Disease control		Individual and group marketing		On-farm storage		Farm management		Improved produce quality		Crop protection		Soil fertility management	
Variables	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Gender (1 if male, 0 if female)	0.1736	0.1254	0.1297	0.1095	0.1357	0.1113	0.1697	0.1241	0.1111	0.1302	0.2679	0.1188	0.2051	0.1380
Age (years)	0.0071	0.0186	-0.0177	0.0146	-0.0184	0.0190	-0.0101	0.0190	-0.0062	0.0182	0.0047	0.0189	-0.0103	0.0170
Age squared	-0.0001	0.0002	0.0001	0.0002	0.0001	0.0002	0.0000	0.0002	0.0000	0.0002	-0.0001	0.0002	0.0000	0.0002
Married (1 if married, 0 otherwise)	-0.1734	0.1292	-0.0445	0.1447	-0.0036	0.1521	-0.0529	0.1461	0.1121	0.1582	-0.1751	0.1325	-0.0321	0.1318
Extension visit (1 if visited, 0 otherwise)	-0.5573	0.1709	-0.2133	0.1550	-0.3458	0.1365	-0.4614	0.1339	-0.3418	0.1291	-0.2540	0.1552	-0.1831	0.1472
Trained by extension agent (1 if trained, 0 otherwise)	-0.1918	0.1853	-0.1379	0.1494	-0.1486	0.1538	-0.0320	0.1383	-0.0059	0.1642	0.0672	0.1805	0.0510	0.1467
Member of farmer organization (1 if member, 0 otherwise)	0.0914	0.2123	-0.1022	0.1737	-0.2405	0.1734	-0.0070	0.1844	-0.1576	0.1751	-0.2938	0.1966	-0.2358	0.1431
Access to information (1 if have access, 0 otherwise)	-0.3704	0.0512	-0.3341	0.0542	-0.3230	0.0538	-0.2828	0.0348	-0.3161	0.0526	-0.3476	0.0533	-0.2626	0.0446
Access to electricity (1 if have access, 0 otherwise)	-0.1636	0.1519	-0.2232	0.1295	-0.1244	0.1564	-0.1401	0.1378	-0.1577	0.1324	-0.0908	0.1575	-0.1463	0.1503
Access to water (1 if have access, 0 otherwise)	0.0028	0.0970	-0.0465	0.0931	-0.0581	0.0815	-0.1125	0.0900	-0.0110	0.0801	0.0255	0.0778	0.0837	0.0866
Market availability (1 if available, 0 otherwise)	0.2794	0.1728	0.3267	0.1656	0.3416	0.1704	0.3094	0.1781	0.2580	0.1653	0.1684	0.1746	0.1254	0.1724
Travel time to market (minutes)	-0.0006	0.0005	-0.0004	0.0005	-0.0009	0.0004	-0.0009	0.0004	-0.0004	0.0004	-0.0006	0.0005	-0.0006	0.0004

Table A.1—Continued

	Disease control		Individual and group marketing		On-farm storage		Farm management		Improved produce quality		Crop protection		Soil fertility management	
Variables	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Owned land (Ha)	0.0451	0.0109	0.0340	0.0121	0.0322	0.0093	0.0440	0.0104	0.0291	0.0108	0.0403	0.0097	0.0373	0.0116
Inherited land (Ha)	0.0340	0.0328	-0.0061	0.0315	-0.0259	0.0293	0.0144	0.0350	0.0156	0.0418	0.0282	0.0392	0.0046	0.0318
Farming income (1,000 Ugandan shillings)	0.0002	0.0001	0.0003	0.0001	0.0001	0.0001	0.0002	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
Other income (1,000 Ugandan shillings)	0.0002	0.0001	0.0003	0.0001	0.0003	0.0001	0.0002	0.0001	0.0003	0.0001	0.0004	0.0001	0.0003	0.0001
Southern region (default)														
Eastern region	0.3271	0.0965	0.1304	0.1117	0.0953	0.1098	0.1668	0.1078	0.3517	0.0967	0.1640	0.1082	0.1177	0.1101
Northern region	0.2550	0.1376	0.0067	0.1327	0.0114	0.1335	0.0948	0.1331	0.2388	0.1298	0.1275	0.1295	-0.0328	0.1280
Western region	-0.2519	0.1141	-0.4998	0.1345	-0.4882	0.1328	-0.5144	0.1097	-0.3651	0.1243	-0.3436	0.1113	-0.4785	0.1056
Intercept	0.4131	0.4783	0.7238	0.3472	1.0201	0.4889	0.6473	0.4616	0.5098	0.4518	0.4788	0.4982	0.7606	0.4455

Source: Authors' calculations from UNHS 2005/06.
Note: Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho32 = rho42 = rho52 = rho62 = rho72 = rho43 = rho53 = rho63 = rho73 = rho54 = rho64 = rho74 = rho65 = rho75= rho76 = 0; chi2(21) = 5721.47; p-value = 0.0000
1 S.E.: standard error

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